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Design on the Active Safety Protect System for Internet of Freight Vehicles

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(Abstract) This design is to establish a freight security system with real-time communication and active safety monitoring. Its purpose is to reduce the traffic accident rate, reduce the loss of goods, and achieve the automatic evaluation of safety performance; these system is an internet of vehicles system with security as the core that building by vehicle MC, PC monitoring software and communication system. It perceives vehicle safety status, protects security, RMON and command by intelligent vehicle MC and PC monitoring software that independent research and development. It creates the 4-layer communication protocol stack based on GPRS / PPP / TCP / IP and transport security data. The design constructs an internet of vehicles composed of freight vehicles, control center, specific phones that is able to protocol conversion, wired / wireless network transmission for signal and full-duplex communication for instruction. The system is designed for dynamic security monitoring of trunk transport, can be achieve real-time automatic security surveillance and remote real-time / delay artificial security monitoring with early warning of non-normal driving, emergency rescue for traffic accidents, the smart anti-theft for whole vehicle and speed limit by two-way and multi-level function, etc. The system provides intelligent and active solution for freight security. Enterprise more refined and dynamic manages transport through this system, can be achieved to reduce traffic accidents, reduce losses and improve the management efficiency.

Keywords: Internet of vehicles; Freight transportation; Active security; System design; Wireless network communication.

1. INTRODUCTION

Internet of vehicles project is listed as the third National Science and Technology Major Project in China and obtains funding from the central capital. Taking vehicle as the basic information unit, Internet of vehicles integrates sensor technology, information collection, access technology, transmission technology, networking technology, the pedestrians, vehicles, roadside facilities such as roads entities and traffic management network, mobile network and back-up network connection, servicing in vehicle safety, traffic control, information services, user network access applications. It aims to improve traffic conditions and travel efficiency, and develop interactive forms of intelligent and integrated network-based information system [1].

As a typical application of Internet of Things, Internet of vehicles clarifies the interconnectivity of vehicles, roads, cities and people. Therefore, it promotes the modernization of network and intelligence of the automotive, transportation, and IT industries. From the perspective of system interaction, it mainly covers cars and trucks, communications systems, vehicles and human communication systems, vehicles and road communication system, car and comprehensive information platform communication system, roads and integrated information platform communication system [2].

At present, research in the field of Internet of vehicles is still in its infancy. There exists much discussion on different levels of Internet of vehicle technology, network structure, and communication protocols. However, in view of the backward in infrastructure construction and standard construction, the ideal Internet of vehicles exists only in theory. Within the framework of Internet of vehicles, and with consider of the characteristics and needs of the transport and logistics enterprises, a truck and a comprehensive information platform communication system is designed, which is part of the motor transport Internet of vehicles safety monitoring system. The design is based on GPRS and an independent research ASPV (Active Safety Protect for the Vehicle, the vehicle active safety prevention and control system, also known as a vehicle intelligent terminal, has obtained the invention patent with patent No: (ZL201010159743.5)

2. TECHNICAL FOUNDATIONS

2.1 Application of GPRS in transporter security and monitoring system

In GPRS packet-switched communication, data is divided into a certain length packets. In front of each packet, there is a packet header (which specifies the address the packet to be sent to). Before data transfer, pre-allocating channel is not compulsively required for establishing connection. When each data packet arrives, according to the header information in data (such as destination address), it temporary seeks an available channel resources to send the data. The main function of the GPRS system is to gather data from each ASPV sensor and to transmit them wirelessly to the monitoring center on a remote computer through GPRS

module, which can be regular or real-time. In consider of heavy-duty processing tasks in the gateway, the ARM-Linux operating system, which supports multi-process and multi-threaded calls, is used to manage the process. This flow is shown in Figure 1.

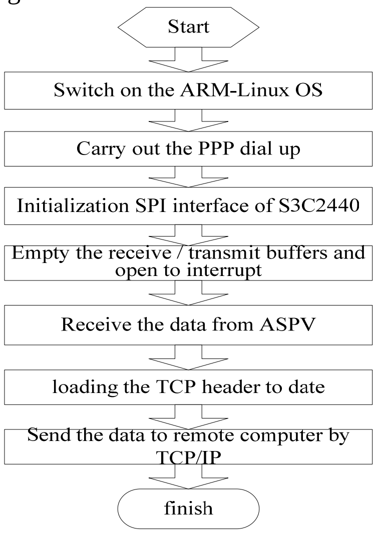

Figure 1. System flow chart

2.2 The application of ASPV

ASPV is an in-vehicle distributed intelligent security terminal, which is composed by host, detector of the carton, steering wheel detectors and remote controller. Installed in the vehicle cab cargo box and steering wheel in a distributed manner, it transfers data through wired or wireless network. The proper functioning of the device relies on integration of integrated GPS module, GPRS module, acceleration sensors, encoders, limit switch, the radio transceiver module, and embedded microprocessors. This enables accurate and dynamic calculation of a variety of data obtained from sensors. Correspondingly, according to designed algorithm, the device is able to measure the security level and actively monitor and protect the vehicle. The monitoring and protection function of device includes driver fatigue warning, help and automatic positioning in a major traffic accident, car anti-theft, car networking, security monitoring and variable over speed warning. By activating GPRS module, it communicates wirelessly with the host computer while by activating the GSM short message module, it communicates with a specific mobile phone number.

3.SYSTEM ARCHITECTURE

3.1 Internet of vehicles security monitoring system network architecture

The design of Internet of vehicles includes the following two parts:

1).Install distributed intelligent in- vehicle terminals and connect them through sensing devices, achieve intelligent monitoring and management.

2). Utilize mobile communication technology to connect in-vehicle terminals with the external network, in order to exchange information between vehicles and the fixed station. The entire system architecture is shown in Figure 2.

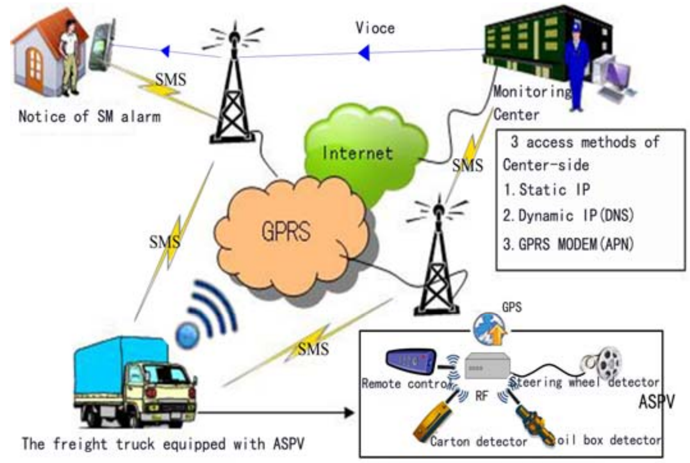

Figure 2. Network Architecture

3.1.1 Network mode.

Vehicles security monitoring network consists of the monitoring center, transport vehicles equipped with ASPV, mobile phone users, GPRS wireless network and Internet. ASPV is equipped as information detection and data transmission terminal, in which GPRS wireless network is able to access the Internet to transfer data and alarm messages can be sent to specific mobile phone users via SMS message. Meanwhile, monitoring center is able to monitor through timed data returned from ASPV or send directed instruction via SMS. Communication link is established under 2-shaking protocol, which enables GPRS communication; the specific phone can receive alarm information from ASPV or send directions to ASPV via SMS.

3.1.2 The network access mode.

The monitoring center can access the Internet via three ways. The first way is fixed IP access. ASPV accesses the Internet via GPRS and seeks the IP address of the monitoring center, establishing a TCP connection for data communication. The second way is dynamic IP access, in which the address of the monitoring center is found through domain name resolution, and establishes a TCP connection for data communication with monitoring center. The third way is GPRS MODEM access. The GPRS MODEM can access the GPRS network and then mobile APN private network, after which accessing the monitoring center to establish a TCP connection for data communications with relatively high costs. ASPV accesses network via GPRS while a specific mobile phone user accesses network through the GSM.

3.2 Internet of vehicles security monitoring system interconnection structure

According to Internet access approaches and functions of various components, the system can be divided into three-level interconnection structure. Shown in Figure 3.

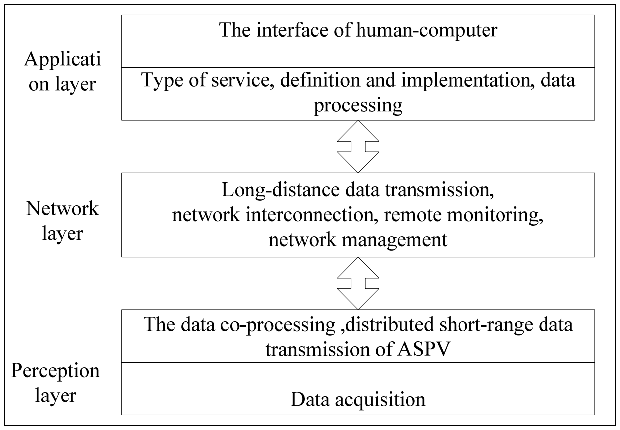

Figure 3. System interconnect

3.2.1 Perception layer

The perception layer can be divided into two sub-layers, lower layer and upper layer. The main functions of the lower layer is to recognize safety related behaviors, percept and collect vehicle information such as location, speed, position, the driver's operation, traffic accidents, theft and other related data; the main function of the upper layer is to transfer data in Self-Organizing Network (ASPV distribution node). Devices used in the Perception layer include various sensors (acceleration perception, angle of steering wheel, the state of cartons door, etc.), GPS and so on.

3.2.2 Network layer

In this system, the main function of the network layer is data processing and long-distance large-scale transmission of data via Internet access; equipment used in the network layer includes Internet GPRS module, which in function is equivalent to a router in a traditional network.

3.2.3 Application layer

The application layer can be further divided into two sub-layers. The lower layer is the application layer and its main function is data processing, a variety of specific services in Internet of vehicle is defined and offered in this sub-layer; the upper sub-layer is human computer interaction interface, which defines the approaches to and contents of user interaction. The equipment used in the application layer includes server computers in monitoring center, and specific users' mobile phones.

4. COMMUNICATION AND MONITORING METHODS

4.1 The communication design for GPRS access the Internet

4.1.1 The model design of GPRS access Internet

The GPRS network is composed of new GPRS service nodes that in the GSM base station, and achieves connection with internet GPRS by gateway node. In the system, data must communicate by wireless with local GPRS service node through GPRS Modem first, and into the GPRS network, and then exchange data with internet via GPRS gateway. The model structure is shown in Figure 4.

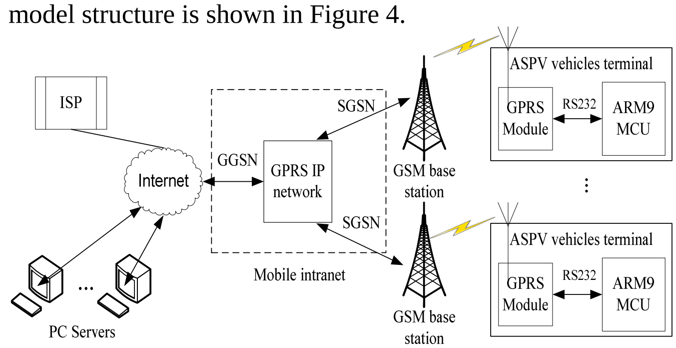

Figure 4. GPRS access to the Internet model

4.1.2 System communication protocol stack

In order to simplify system communication protocol stack, in this design, GPRS related services and GPRS internal nodes are simplified as GPRS network, GPRS internal protocol and the Internet gateway protocol are simplified as GPRS Gateway Protocol. Protocol stack structure is shown in Figure 5.

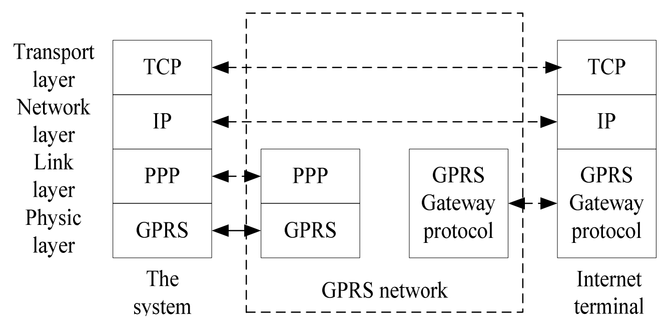

Figure 5. system communication protocol stack

l) Physical layer:
Embedded ARM microprocessor dials and sends AT instruction through GPRS Modem. After the right feedback and response, a physical channel, known as GRRS channel, is established between the GPRS Modem and GPRS network.
2) Data Link Layer:
PPP protocol the original GPRS physical layer connection transformed into error-free data link, the system will a remote login to the Internet and obtain the IP address assigned by the Gateway GPRS.
3) Network Layer:
IP protocol is applied as the network layer protocol, which connects terminals with different IP addresses. Through IP routing selection, data is shared in terminals of different IPs on the Internet.
4) Transmission layer:
TCP is used as the transport layer to provide connection-oriented and reliable service for data transmission.

4.1.3 Software Design

In the application layer, GIS is the key for the secondary development of half-duplex communication. B/S architecture

is adopted in the host computer, which enables real-time graphic display of terminal vehicle distribution and transportation safety status; in linking layer, PPP protocol is adopted, and based on it，IP packet is encapsulated; in transmission layer, simplified TCP/IP protocol stack (ICMP protocol) is applied, which supports only echo protocol (response PING command) for debugging purpose; MFC socket interface is designed; for embedded ARM9 processor, ANSI C language and ADSl Compiling Environment and midrange storage mode are applied.

GPRS communication process is as follows: power-on reset, basic parameter settings, and then dial-up PPP negotiation, including LCP negotiation, PAP negotiation, and IPCP negotiation system. Dynamic IP is obtained and the GPRS Internet access is established. Embedded ARM microprocessor encapsulates user data into IP packets, and then PPP packets, which are sent to GPS module through the serial port. And the packets are sent to CPRS net after being encapsulated into GPRS packet data. Packet reception process goes to the opposite direction [4].

4.2 System security monitoring methods

The monitoring system of Internet of vehicles includes automatic real-time
monitoring and remote real-time/delay artificial monitoring.

Automatic real-time monitoring includes driver fatigue monitoring and early warning, monitoring of major accidents, automatic positioning and remote assistance, anti-theft monitoring and alerts, variable speed monitoring and alarm. Automatic real-time monitoring relies on data gathered from sensors of ASPV monitoring and distributed detectors. The data is analyzed by the embedded ARM-Linux systems according to a scheduled program. Automatic real-time monitoring is active safety protection of vehicles, in which data received from automatic real-time monitoring will be stored in the historical database and a copy will be sent to the monitoring center for analysis and evaluation to ensure safe driving.

Remote real-time/delay human surveillance include the help of a major traffic accident monitoring and positioning and the entire vehicle anti-theft monitoring and alarm and variable speed monitoring and alerts and traffic track monitoring. The realization of remote real-time / delay and artificial supervision rely on data received from the GPRS module of ASPV. Data will be processed packaged and transferred to the control center via wireless network from time to time or momentarily. In the monitoring center, remote vehicles are managed in manual way.

The functions of remote real / artificial delay monitoring cover remote early warning of a major traffic accident and rescue halt vehicle anti- thefts early warning and location tracking, remote control of speed limit, vehicle running track display and remind of fee dues on terminals.

5. CONCLUSION

In Internet of vehicles, vehicles, vehicle management and Vehicle scheduling construct a synergy system. This integrated system achieves real-time management of vehicles, provision of real-time and accurate information, vehicle tracking and positioning, security monitoring, emergency rescue, path selection, logistics network design and optimization, which aims to enhance the competitiveness of logistics enterprises. In the integrated network, vehicles are managed in a more refined and dynamic way; vehicles, logistics and passenger can collaborate more rationally and intelligently.

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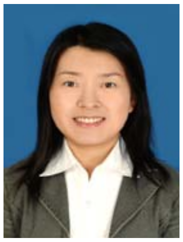
Author Introduction



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